

## **Remarks**

### **1. Summary of Office Action**

In the final Office Action mailed December 7, 2007, the Examiner rejected claims 1-6, 9-11, and 18-23 under 35 U.S.C. § 103(a) as being obvious over a combination of Figure 1 of Applicants' application and U.S. Patent No. 5,646,991 (hereinafter "Sih"), the Examiner rejected claims 13-17 under 35 U.S.C. § 103(a) as being obvious over a combination of Figure 1 of Applicants' application, Sih, U.S. Patent Application Pub. No. 2004/0078104 (hereinafter "Nguyen"), and U.S. Patent No. 6,891,954 (hereinafter "Takahashi"), the Examiner rejected claims 7 and 8 under 35 U.S.C. § 103(a) as being obvious over a combination of Figure 1 of Applicants' application, Sih, Nguyen, and U.S. Patent No. 6,122, 506 (hereinafter "Lau"). In addition, the Examiner objected to the specification on the basis of informalities.

### **2. Amendments to the Claims**

Applicants have canceled claims 18-23. Further, Applicants have amended independent claims 1, 5, 9, and 13 to recite the invention more particularly, as supported by Applicants' specification (*see, e.g.*, paragraphs 0021-0022 and 0045-0046).

Presently pending in this application are claims 1-17, of which claims 1, 5, 9, and 13 are independent and the remainder are dependent.

### **3. Response to Specification Objections**

The Examiner commented that, as illustrated, the elements of a second echo canceler adaptive filter 84 (Figure 1), an echo canceler filter 216, an echo canceler coefficient logic 218, and a filter coefficient data generator 220 (Figure 2) do not receive

any downlink data 52 for echo modeling/cancellation (*see* Office Action, items no. 1, 4, and 5).

As shown in Figure 1 depicting a *cascaded* echo canceler adaptive filter arrangement, the second echo canceler adaptive filter 84 receives first post-echo canceler uplink data 90 produced by a first adder logic 82. The first adder logic 82 produces this first post-echo canceler uplink data 90 using pre-echo canceler uplink data 64 and first echo estimation data 88 from a first echo canceler adaptive filter 80. As illustrated, it is the *first* echo canceler adaptive filter 80 in this *cascaded* arrangement that directly receives the *downlink data* 52 and produces the first echo estimation data 88 used by the first adder logic 82 to produce the first post-echo canceler uplink data 90, which is then subsequently used by the second post-echo canceler filter 84 to produce final post-echo canceler data 98. (*See, e.g.*, Applicants' specification, paragraphs 0009 and 0010). Thus, the downlink data 52 is used by the cascaded filter topology, including the second echo canceler adaptive filter 84, for echo cancellation.

Similarly, with respect to Figure 2, Applicants' specification notes that a pre-noise suppression logic 210 effectively performs at least some of the functions of the *first* stage of the overall cascaded (adaptive filter) echo canceler. In turn, an echo canceler logic 214 effectively performs at least some of the functions of the *second* stage of the overall cascaded echo canceller and includes the echo canceler filter 216 and the echo canceler coefficient logic 218 comprising the filter coefficient data generator 220 and an adder logic 222.

As illustrated in Figure 2 and described in the specification, the pre-noise suppression logic 210 receives pre-echo canceler uplink data 64 and the *downlink data*

52, and in response produces pre-noise suppression uplink data 224. In turn, the echo canceler coefficient logic 218 receives the pre-noise suppression uplink data 224 (produced by the pre-noise suppression logic 210 based on the downlink data 52) and the pre-echo canceler uplink data 64, and in response produces filter coefficient data 226. The filter coefficient data 226 is then provided to the echo canceler filter 216, which produces final uplink data 230. (*See, e.g.*, Applicants' specification, paragraphs 0023-0030. *See* also paragraph 0033 of the specification that describes in more detail how the downlink data 52 is processed within the pre-noise suppression logic stage to produce the pre-noise suppression uplink data 224 that is subsequently used by the echo canceler filter 216 and the echo canceler coefficient logic 218/the filter coefficient data generator 220).

Further, the Examiner objected to the specification on the basis that it is not clear what the echo canceler filter 216 is doing (*See* Office Action, items no. 2 and 3). As noted in the specification, the echo canceler filter 216 receives the noise suppressed uplink data 228 and the filter coefficient data 226, and in response produces final uplink data 230.

As discussed in the specification, an echo canceler adaptive filter typically employs a finite impulse response (FIR) filter having a set of weighting *coefficients* to model the acoustic coupling channel between a speaker and a microphone. The echo canceler adaptive filter attempts to model the acoustic coupling channel by dynamically adapting the weighting coefficients of the finite impulse response filter. (*See, e.g.*, Applicants' specification, paragraph 0006).

In one example, the echo canceler filter 216 may perform this type of adaptive filter function on the noise suppressed uplink data 228 in order to remove or reduce the echo component from the noise suppressed uplink data 228 by applying the filter coefficient data 226. As explained in the specification, the filter coefficient data 226 is produced by the echo canceler coefficient logic 218 that models the changing acoustic coupling channel to update the coefficients used by the echo canceler filter 216. Thus, Applicants respectfully submit that one skilled in the art would understand how signals 226 and 228 would be used by the echo canceler filter 216 to produce signal 230.

As to signals 94 and 96 shown in Figure 1, the specification notes that the second adder logic 86 receives the first post-echo canceler uplink data 90 and second echo estimation data 92 from the second echo canceler adaptive filter 84 to produce second post-echo canceler uplink data 94. As shown in Figure 1, the second post-echo canceler uplink data signal 94 is then applied as an input to the second echo canceler adaptive filter 84 that receives the pre-echo canceler uplink data 64 and produces final post-echo canceler uplink data 98.

Finally, in item no. 7, the Examiner asserted that it is not clear what the amplifier 430 in Figure 4 is doing with the input signals.

As shown in Figure 4, the amplifier 430 receives a downlink audio signal 470 and a playback audio signal 439. As noted in the specification, an in-vehicle audio system may include an amplifier, speakers and an audio source, such as a tuner module, CD/DVD player, tape player, satellite radio, etc. For instance, an audio system 420 shown in Figure 4 includes an amplifier 430, at least one speaker 432, a tuner module 434, a tape player 436 and a CD/DVD player 438. As shown, the audio system 20 may

provide the playback audio signal 439 as an input to the amplifier 430. Further, the amplifier 430 may also receive a separate downlink audio signal 470 from a D/A 440 as an input to the amplifier. As shown, the amplifier 430 outputs an amplified downlink audio signal 472 that is then provided to the speaker 432. Applicants believe that one skilled in the art would understand that the amplifier 430 could selectively amplify each of the two separate input signals.

#### **4. Response to §103 Claim Rejections**

##### **i. Claims 1-6, 9-11, and 18-23**

As noted above, the Examiner rejected claims 1-6, 9-11, and 18-23 on grounds of obviousness over a combination of Figure 1 of Applicants' application and Sih. Claims 18-23 have been canceled, thus rendering the rejections moot with respect to these claims. Further, Applicants respectfully traverse these rejections of claims 1-6 and 9-11, because the cited combination fails to disclose or suggest every element of any of these claims, as would be required to establish a *prima facie* case of obviousness under M.P.E.P. § 2143.

As now amended, claim 1 for instance, recites an echo canceler circuit comprising: (i) pre-noise suppression logic operative to receive pre-echo canceler uplink data and downlink data and in response to produce pre-noise suppression uplink data; (ii) noise suppression logic, operatively coupled to the pre-noise suppression logic, and operative to receive the pre-noise suppression uplink data and in response to produce noise suppressed uplink data; (iii) echo canceler coefficient logic, operatively coupled to the pre-noise suppression logic, and operative to receive the pre-noise suppression uplink data and the pre-echo canceler uplink data and in response to produce filter coefficient

data that is independent of the noise suppressed uplink data produced by the noise suppression logic; and (iv) an echo canceler filter, operatively coupled to the noise suppression logic and to the echo canceler coefficient logic, and operative to receive the noise suppressed uplink data and the filter coefficient data and in response to produce final uplink data. (Other independent claims (as well as their dependents) each include similar limitations).

Applicants respectfully submit that the cited combination fails to disclose or suggest any echo canceler circuit that is arranged in this claimed manner.

In the Office Action, with respect to Figure 1, the Examiner stated that “applicant’s admitted prior art does not show a noise suppression stage coming after the ‘pre-noise suppression logic’ but before the echo canceller filter”. The Examiner then turned to Sih in an effort to reconstruct the claimed invention. More particularly, the Examiner noted that “Sih discloses an acoustic echo canceler (Fig. 5) comprising noise suppressor 146 coupled before the echo canceler.” The Examiner then concluded that it would have been obvious “to implement a high pass filter noise suppressor before either echo cancellation stage [of Figure 1] in order to remove a portion of the background noise.”

Applicants’ respectfully submit that the claimed echo canceler circuit does not merely comprise a noise suppression logic coupled before an echo canceler filter. Among other limitations, the presently claimed invention also *further* requires, e.g., that the echo canceler circuit be arranged such that: *the echo canceler filter receives the noise suppressed uplink data from the noise suppression logic and the filter coefficient data from the echo canceller coefficient logic, where the echo canceler coefficient logic*

*produces filter coefficient data that is independent of the noise suppressed uplink data produced by the noise suppression logic.*

A careful reading of Sih reveals that the echo canceler disclosed in Sih is arranged in the manner that is inconsistent with this claimed invention.

Specifically, in connection with Figure 4 illustrating in detail the structure of echo canceling adaptive filter 112, at col. 7, lines 11-23, Sih discloses that:

*“Coefficient generator 126 receives the echo residual signal  $e(n)$  output from summer 108 (FIG. 2) and generates a set of coefficients  $h_0(n)$ - $h_{N-1}(n)$ . These filter coefficient values  $h_0(n)$ - $h_{N-1}(n)$  are respectively input to multipliers 122<sub>0</sub>-122<sub>N-1</sub>. The resultant output from each of multipliers 122<sub>0</sub>-122<sub>N-1</sub> is provided to summer 124 where they are summed to provide the estimated echo signal  $y(n)$ . The estimated echo signal  $y(n)$  is then provided to summer 108 (FIG. 2) where it is subtracted from the echo signal  $r(n)$  to form the echo residual signal  $e(n)$ . In the traditional echo canceller of FIG. 2, a control input is provided to generator 126 to enable coefficient updating when no near-end speech is detected by circuitry 110.”*

(Emphasis added).

As disclosed in Sih, the summer 108 produces the echo residual signal  $e(n)$  used for coefficient generation *using signal  $r(n)$  that is the sum of the echo signal  $y(n)$  and the near-end speech signal  $v(n)$  and that is filtered through the high-pass filter 146 to remove low-frequency noise.*

Similarly, in connection with Figure 5 noted by the Examiner, Sih teaches that:

*“To remove low-frequency background noise, the sum of the echo signal  $y(n)$  and the near-end speech signal  $v(n)$  is high-pass filtered through filter 146 to produce signal  $r(n)$ . The signal  $r(n)$  is provided as one input to each of summers 148 and 150, and control unit 152.”*

As disclosed in Sih, summers 148 and 152 produce, respectively, signals  $e(n)$  and  $e1(n)$  *using the signal  $r(n)$ .* Further in connection with Figure 5, Sih teaches that:

“Referring back to FIG. 4, the control input *provided to generator 126 includes an enable signal from control unit 152 which permits coefficient vector generator 126 to update the filter coefficients for filter adaptation.* In the event that the ERLE of both filters is less than VT, state machine 180 disables coefficient vector generator 126 from providing updated coefficients. In this case coefficient vector generator 126 outputs the existing coefficients until adaptation is enabled once again. *The control input also provides other parameters to coefficient vector generator 126 such as the values of  $\mu$ ,  $E_{xx}(n)$  and  $e(n)$  of Equation (4).*”

(Emphasis added).

Therefore, the echo canceler logic circuit of Sih is arranged to use the noise-filtered uplink signal  $r(n)$  for generation of filter coefficients used by an echo canceling filter.

In contrast, Applicants’ claimed invention calls for *an echo canceler filter that receives noise suppressed uplink data from a noise suppression logic and filter coefficient data from an echo canceller coefficient logic, where the echo canceler coefficient logic produces filter coefficient data that is independent of the noise suppressed uplink data produced by the noise suppression logic.*

Therefore, modifying Figure 1 of Applicants’ application with the noise suppressor of Sih in the manner proposed by the Examiner would have resulted in an echo canceler circuit *that is different* from that claimed by Applicants.

As noted in Applicants’ specification, among other advantages, the claimed invention performs both echo cancellation and noise suppression in a non-interfering manner. The noise suppression logic does not interfere with the generation of the filter coefficient data because the echo canceler coefficient logic receives pre-noise suppression uplink data without having been first processed in the noise suppression logic. Accordingly, the echo canceler coefficient logic models the changing acoustic

coupling channel and produces the filter coefficient data without any interference from the noise suppression logic. As a result, the echo canceler coefficient logic functions independently from the noise suppression logic.

Although the echo canceler filter receives the noise suppressed uplink data from the noise suppression logic, the generation of filter coefficient data is unaffected by the noise suppression logic. Therefore, the echo canceler filter may perform the adaptive echo cancellation function on the noise suppressed uplink data based on the independently generated filter coefficient data. As a result, the echo canceler filter produces final uplink data that has both been processed for echo cancellation and noise suppression, such that these functions are performed in a non-interfering manner. Since the noise suppression function is not introduced until after the modeling of the acoustic coupling channel and the generation of filter coefficient data, the generation of the filter coefficient data is independent of the noise suppressed uplink data.

Because the cited combination does not teach or suggest all of the elements of any of claims 1-7 and 9-11, the cited combination fails to render these claims obvious under 35 U.S.C. § 103.

#### **5. Response to §103 Claim Rejections of Claims 13-17**

The Examiner rejected claims 13-17 on grounds of obviousness over a combination of combination of Figure 1 of Applicants' application, Sih, and Nguyen. Applicants respectfully traverse these rejections, because the cited combination fails to disclose or suggest every element of any of these claims, as would be required to establish a *prima facie* case of obviousness under M.P.E.P. § 2143.

For at least the same reasons discussed above with respect to independent claims 1, 5, and 9, Applicants respectfully submit that independent claim 13 is patentably distinct over the combination of Figure 1 of Applicants' application and Sih. Further, Applicants respectfully submit that Nguyen fails to make up for the deficiencies in Figure 1 of Applicants' application and Sih with respect to the claimed invention.

Applicants do not concede that the remarks made by the Examiner with respect to claims 13-17 are correct. However, Applicants respectfully submit that those points are moot in view of the fact that the cited combination of Figure 1 of Applicants' application and Sih fails to disclose or suggest the invention as recited in each of claims 13-17.

**6. Response to §102 Claim Rejections of Claims 7, 8, and 12**

The Examiner rejected claims 7, 8, and 12 on grounds of obviousness over a combination of combination of Figure 1 of Applicants' application, Sih, and other various cited art (*see* "Summary of Office Action" section above). Applicants respectfully traverse these rejections.

Each of claims 7, 8, and 12 depends from an independent claim 5 or 9 and therefore incorporates all of the elements of claim 5 or 9. As discussed above, the cited combination of Figure 1 of Applicants' application and Sih fails teach or suggest the invention as recited in any of claims 5 and 9. Therefore, the cited combination of Figure 1 of Applicants' application and Sih also fails to teach or suggest the invention as recited in any of claims 7, 8, and 12. Further, Applicants respectfully submit that other cited art fail to make up for the deficiencies in Figure 1 of Applicants' application and Sih with respect to the claimed invention.

## 7. Conclusion

In view of the foregoing, Applicants submit that claims 1-17 are in condition for allowance. Therefore, Applicants respectfully request favorable reconsideration and allowance of those claims.

Respectfully submitted,

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By:           /Joanna Skyles/          

Joanna Skyles  
Reg. No. 54,454

Temic Automotive of North America, Inc.  
Patents and Licenses  
21440 West Lake Cook Road  
Deer Park, IL  
Tel.: (847) 862-0274  
Fax: (847) 862-8308